and others, samples of dry alfalfa hay are routinely milled and extracted in a Soxhlet extractor by use of a nonpolar solvent such as hexane. Dieldrin levels extracted from similar field samples by this technique and levels extracted by additional chloroform-methanol extraction in a Soxhlet apparatus are compared in the lower portion of Table 1. Approximately 70 percent of the total insecticide found was in the hexane extract.

All test data indicate that Soxhlet extraction with chloroform-methanol removes all the internal insecticide found in finely ground samples of dry hay. This single-solvent system is not effective, however, when used on fresh crop materials.

The evidence suggests that routine extraction techniques with a single-solvent system, using either hexane or hexane–isopropyl alcohol mixture, cannot quantitatively extract the compounds in question when they are present within the plant. In view of the extraction results, one may hypothesize that the chlorinated-hydrocarbon insecticides are deposited in the surfactant lipids of these plants (phospholipids, sulfolipids, and glycolipids). These lipids are quite polar in nature and are not quantitatively extracted by the *n*-hexane–isopropyl alcohol mixture. On the other hand chloroform-methanol is a far better solvent for these lipids, which fact supports the theory that the pesticides and lipids may be physically or chemically associated.

Ralph O. Mumma
Department of Biochemistry,
Pennsylvania State University,
University Park
Willis B. Wheeler
Donald E. H. Frear
Pesticide Research Laboratory,
Department of Entomology
Robert H. Hamilton
Department of Botany

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Hydrodynamic Performance of Porpoises (Stenella attenuata)

Abstract. *Two specimens of* Stenella attenuata, *trained to chase a winch-towed lure, reached a top speed of 11.03 meters per second (21.4 knots) in 2.0 seconds. The maximum power output, occurring 1.5 seconds after the start, was calculated from measured values of acceleration and drag coefficient. The maximum power output per unit body weight was 50 percent greater than for human athletes. The measured drag coefficient, obtained from periods of coasting, was approximately the same as that of an equivalent rigid body with a near-turbulent boundary layer.*

Research on the top speed of porpoises has been stimulated by reports of unusually high speeds relative to predicted speeds. The well-known "Gray's paradox" stems from analysis (*1*) of the performance of a 91-kg porpoise that was clocked at a speed of 10.3 m/sec (20 knots) for 7 seconds; drag was calculated to be severalfold lower (otherwise the power output was severalfold higher) than that expected of a torpedo-like body with a power output equivalent to that of a human being.

The top speeds of wild porpoises reported in the literature (*2*) generally range from 9.2 to 10.3 m/sec for durations of less than 10 seconds. Top speeds of 8.76 to 9.28 m/sec for 8 to 25 minutes have been reported by shipboard observers, and fast-moving herds have been stated to travel at 5.16 to 7.22 m/sec for somewhat longer periods. Differences in performance between species are noted, inshore species being generally slower than the pelagic species.

Some observations of high speed result from assisted locomotion (*3*), where the animal derives thrust from the ship's waves or from the bow pressure field. Many of the short-term high-speed bursts can be explained by the great power output of muscles that go into an oxygen debt. For example, human athletes can produce 457 kg m sec^{-1} (6.0 horsepower) in a single movement of arms and legs, 145 kg m sec^{-1} for 6 seconds, 69 kg m sec^{-1} for 1 minute, and 15.2 kg m sec^{-1} for 1 day (*4*). The power ratio may be 30:1, depending upon the duration of exertion. Gray's paradox can be largely resolved by consideration of duration; his analysis was based on the power output of humans for a 15-minute period and was therefore biased by a factor of about 3.5.

Recently reported (*5*) are considerable differences in power output between porpoises of different species. The highly active pelagic species *Phocoenoides dalli* was credited with about 1.7 times the total blood-oxygen content of the less active pelagic species *Lagenorhyncus obliquidens* and nearly 3.0 times that of coastal *Tursiops truncatus*. The top speeds of these three species lie in the same order and generally within the range of speeds reported by Gray (*1*). An exception may be *Phocoenoides dalli* which is reported to be able to accelerate rapidly ahead of a 32-km/hour capture boat for 50 to 100 m after riding the bow wave for 5 minutes or more. Some of the more unusual top speeds reported in (*1*) and analyzed in (*6*) might be explained by the unusually large blood-oxygen content of the pelagic species. Speed tests with the aid of calibrated instrumentation under controlled conditions are needed for accurate measurement of speed and power.

Performance of a trained young adult female Pacific striped porpoise (*Lagenorhyncus obliquidens*) was tested in 1961 in a 96-m tank, 2 m deep (*7*). Top speed of the 91-kg animal, 7.76 m/sec, developed in about 2 seconds; maximum-acceleration power output after about 1 second was 160 kg m sec^{-1} at 4.59 m/sec, and the best estimate of the measured drag-area coefficient (drag/dynamic pressure) was 0.0056 m^2. No unusual performance was found.

In 1964 a trained, 89-kg 3-year-old, male, Pacific bottlenose porpoise (*Tursiops gilli*) was tested for speed along a racecourse in a 300-m lagoon, 3 m deep, at Coconut Island, Oahu, Hawaii (*8*), and in the open sea near Rabbit Island and in Kaneohe Bay, Oahu (*9*), where the animal was trained to pursue a speedboat. Maximum speeds were 8.30 m/sec for 7.5 seconds, 7.01 m/sec for 10 seconds, and 6.09 m/sec for 50 seconds; the results generally compared closely with predictions. Only the 7.5-second top speed was somewhat unusual, indicating either about 40-percent greater power per unit body weight than the power of athletes or equivalent reduction in drag.

In March 1965 a new kind of speed-run training was initiated with two subadult male specimens of *Stenella attenuata*, a pelagic species believed capable of unusually high speed. The smaller animal weighed 40.5 kg and was 1.69

m long; the other, 52.7 kg and 1.86 m. Because this genus tends to be comparatively slow to learn, appears depressed in solitude, and adapts poorly to changes in routine, it had not been used previously. The animals were trained to chase a wood lure, 1.6 cm in diameter, 36 cm long, and painted yellow. The lure, attached to a 23-kg-test monofilament nylon line, was towed near the surface by a ¾-hp variable-speed, electric-powered winch capable of preselected steady lure speeds up to 15.5 m/sec.

The tests were conducted along a racecourse laid out in 4 m of sea water in the 300-m by 35-m lagoon at Coconut Island. The lagoon water was clear and generally free from surface waves. We used a calibrated 16-mm Bolex motion-picture camera mounted 10 m ahead of the finish line on a platform 4.9 m above water and overlooking the racecourse; the horizontal distance from animals to camera varied from 2 to 3 m. Speed was reduced from the camera data by use of the animals as a length scale, frame rate for time, and fixed markers as reference points.

The first phase of training consisted of rewarding the animals for entering and leaving their pen, following the work boat, progressing down the unfamiliar lagoon to the barrier net, and for passing near and under a cork-buoyed line used to mark the racecourse. The animals had previously been conditioned to the food-reward system and habituated to swimmers, boats, and a lagoon situation. Next, the animals were rewarded for touching a floating or towed lure, and then for overtaking a moving lure reeled toward or away from the boat by a fishing pole. During this phase of training one animal became fouled in the monofilament line and had to be caught and cut free. Both animals evinced caution and fear of the line thereafter, but not of the lure.

When the animals had learned to track the lure, a plastic finish line was positioned at a depth of 1 m and the animals were rewarded if they crossed the line simultaneously with the moving lure. If they fell behind before crossing the finish line, they were not rewarded. After a run, an assistant in the boat retrieved the lure and returned it to the starting point; the porpoises generally swam near the boat and positioned for another run.

During runs, the trainer stood on the camera platform near the finish line, from which he could observe and direct by walkie-talkie radio the operators of boat and winch. Run lengths were varied and lure speeds were gradually increased over a period of several weeks. Both animals were rewarded for each satisfactory run, although the larger and dominant animal was often closer to the lure. (No competition between the animals was noted; the usual result of competition in this species is that the less-dominant animal ceases to work.)

A behavior chain at the start of each run was established in which the assistant in the boat stood and raised the lure aloft. The animals swam toward the bow, and the lure was dropped in the water behind them; they circled and came in behind the lure, facing downcourse. When they had a 2- to 3-m start, the trainer radioed the winch operator, who started the lure; this procedure permitted animals and lure to reach top speed at the same time. Establishment of the "start" pattern permitted the trainer to give the animals several minutes rest between runs without anticipatory racing developing.

Runs were held in two daily 40- to 80-minute training sessions. Run lengths were extended by up to 8 m a day and run speeds were increased 1 knot at a time. Simultaneous increase in speed and length of run resulted in premature "finishes" from the animals; therefore, when the run length had been established at over 30 m, all further efforts were concentrated on increase in speed. The gradual increases were made desirable by the tendency of this species to become confused by any sudden change in procedure or criteria.

Once speeds of 6 to 8 m/sec had been established, the animals appeared disinterested in participating in slower runs. As in most conditioned behaviors involving long duration or great exertion, performance declined rapidly if more than three or four runs went unrewarded or if the reward was minimal. The animals were trained on about 5.5 kg of fish daily apiece; about 0.2 kg was presented to the pair after each successful run.

Although performance normally declined toward the end of each training session of 15 to 20 runs, the respiration rate did not appear to increase markedly; this was perhaps because power output was limited more by muscular oxygen debt than by body metabolism and respiration rate, which would be limiting factors on longer runs. Satiation and consequently decreased motivation also may have been a factor.

In addition to the normal speed runs, some runs were conducted in which the lure was suddenly halted near the finish line; the animals would then normally coast for another 10 to 15 m downcourse. The coasting to a stop provided valuable data on drag. The winch was specially designed for instant braking without backlash.

Drag-area coefficient (drag/dynamic pressure), D', was calculated for the larger porpoise from the five coasting runs that had clearest motion picture coverage by use of the following equation:

$$D' = (\text{drag})/(\rho V^2/2) = -\ 1.05\, m\, a/(\rho V^2/2)$$

where m is mass of the porpoise, a is (negative) acceleration, ρ is water density at 32.2°C, V is instantaneous speed, and 1.05 represents the added 5 percent of effective underwater mass, called virtual mass, contributed by the water carried along. Values of D' ranged from 0.00288 to 0.00483 m^2 and averaged 0.00373 m^2; the scatter is primarily caused by inaccuracy in calculating deceleration from distance and time data.

This measured value compares closely with the value of 0.00326 m^2 calculated by conventional methods (*10*) in which Reynolds-number effects, body size and shape, fin-appendage sizes and shapes, and fin-body interferences are included; the calculations are based on a near-turbulent boundary layer in view of the flow disturbances produced around the lower half of the forebody by the mouth, rostrum-melon juncture, and eyes. The calculated wetted areas of the body and appendages are 0.772 and 0.170 m^2, respectively. The estimated drag added by the appendages was 28 percent of the estimated body drag. The Reynolds number of the body at top speed in 32.2°C sea water is 22.6×10^6, and a typical maximum Reynolds number for the appendages is 0.9×10^6.

All final data were based on a course length of 25 m, and only data on the larger porpoise were evaluated. The power output was calculated for six of the fastest runs. The portion of power appearing as acceleration, P_A, and the portion P_D, used to overcome frictional drag, were calculated as follows:

$$P_A = 1.05\, m\, a\, V/\eta \qquad P_D = (D'\rho\, V^3/2)/\eta$$

where a is (positive) acceleration and η is propulsive efficiency (which is assumed to be 90 percent and therefore representative of the better submerged-body propulsors). The highest values of P_A were 229, 254, and 278 kg m sec^{-1}.

By use of the average measured value for D', values for P_D were calculated and added to each corresponding value of P_A to obtain total power output at each instant during acceleration. The total maximum power outputs were 387, 419, and 461 kg m sec^{-1} (5.08, 5.51, and 6.05 hp) for the three fastest runs. The calculated peak power output generally occurred about 1.5 seconds after the initial acceleration and about 0.5 seconds before top speed was reached; this fact suggests that the initial maximum power burst can last only 1.5 seconds. During the earlier stages of acceleration, the power output increased gradually from around 250 or 300 kg m sec^{-1} to the maximum reported power. Results show that maximum power output per unit body weight is about 1.5 times the maximum (3.6 kg m sec^{-1} per kilogram) reported (*4*) for a human athlete. Since human athletes can produce such power only during a single jerking movement of arms and legs, a crude extrapolation from the power data presented by Wilkie (*4*) suggests that, for a 1.5-second period, the power output by a poropise may be greater than that by a human athlete by a factor of 2.5. Such greater power might be explained by one or more of these factors: greater ratio of muscle weight to body weight, better distribution of muscles, or greater oxygen content in the blood.

Maximum speed recorded during the tests was 11.05 m/sec (21.4 knots). Speed generally decreased by 10 to 20 percent soon after top speed had been reached, although the animals appeared to continue swimming fast. The calculated power output at top speed was 292 kg m sec^{-1}, 30 percent below the maximum power output for that run. The next highest speeds were 10.35 and 10.30 m/sec (20.1 and 20.0 knots). There is evidence that the top speed of one other run, not reduced because of poor camera exposure, was in the region of 11 m/sec. Distance from the start to the point of top speed generally varied from 13 to 17 m—7 to 9 body lengths; time to top speed averaged 2.0 seconds.

Detailed analysis of the speed-versus-time data tend to support the assumption that the porpoise's drag coefficient when swimming is approximately the same as when coasting; if it were significantly less when swimming, the calculated power output at top speed would be much lower than the calculated power peak that occurs during acceleration. On the other hand, if it were much greater when swimming, the power calculated in the early stages of acceleration would be much lower than the power calculated near top speed. Both these extremes appear unlikely from the training and physiological viewpoints.

An alternate check of top speed was made in an oceanaruim at Sea Life Park, Oahu, where two other specimens of *S. attenuata* were trained with four spinner porpoises to swim at high speed around a 70-m path circling a small island in a tank. The animals appeared to travel at extremely high speed, but reduction of data showed top speeds of only 7.7 to 8.3 m/sec, 2 to 3 seconds after the start.

Thomas G. Lang
Karen Pryor
U.S. Naval Ordnance Test Station, Pasadena, California, and *Oceanic Institute, Waimanalo, Oahu, Hawaii*

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Pteridines in the Fat Body of a Mutant of Drosophila melanogaster

Abstract. *A mutant,* white-mottled orange, *which deposits less than wild-type amounts of drosopterins in the eyes, has been found in* Drosophila melanogaster. *Variations in other pteridines were also observed. The mutant accumulates and later loses drosopterins in the abdominal fat body of adults.*

A spontaneous eye color mutant, *white-mottled orange* (w^{mo}), was found in a mass mating of *Drosophila melanogaster* where females were attached-X and males *maroon-like (ma-l)*. When crossed with *yellow, scute, miniature, forked*, it was located at 1.5 ± units from the distal end of the X chromosome. The mutant was removed from *ma-l* stock and the phenotype proved to be mottled. A stock was established, but it still appears to be somewhat variable in phenotype. Generally, eyes of both males and females are light, mottled orange in color on emergence. During the first 3 or 4 days of adult life, when raised at 25°C, the color of the male's eyes becomes almost brown, while the color of the female's eyes remains considerably lighter.

Mutant w^{mo} was tested in combination with several other mutants. With *ma-l* both males and females have the same eye color on emergence as the mutant without *ma-l*, but the eyes remain much lighter when *ma-l* is present and no mottling is present with *ma-l*. The new mutant, heterozygous with *white*, has very dark eyes on emergence—about the color of older *ma-l* alone—which do not appear mottled. The mutant in combination with *white-Brownex* is lighter in color than when combined with *white* and again does not appear mottled. Interaction between *white-apricot* and w^{mo} causes about the same coloration as the *white-Brownex* combination does, but the eyes appear mottled. The new mutant in combination with *scarlet, vermillion,* or *brown* gives colors slightly lighter than the mutant alone and the colors are not mottled. None of these combinations darkens with age as w^{mo} alone does.

In order to survey eye pteridines, single heads of the mutant w^{mo} were mashed directly on Whatman No. 1 chromatographic paper. The chromatograms were developed at 18°C in dark-